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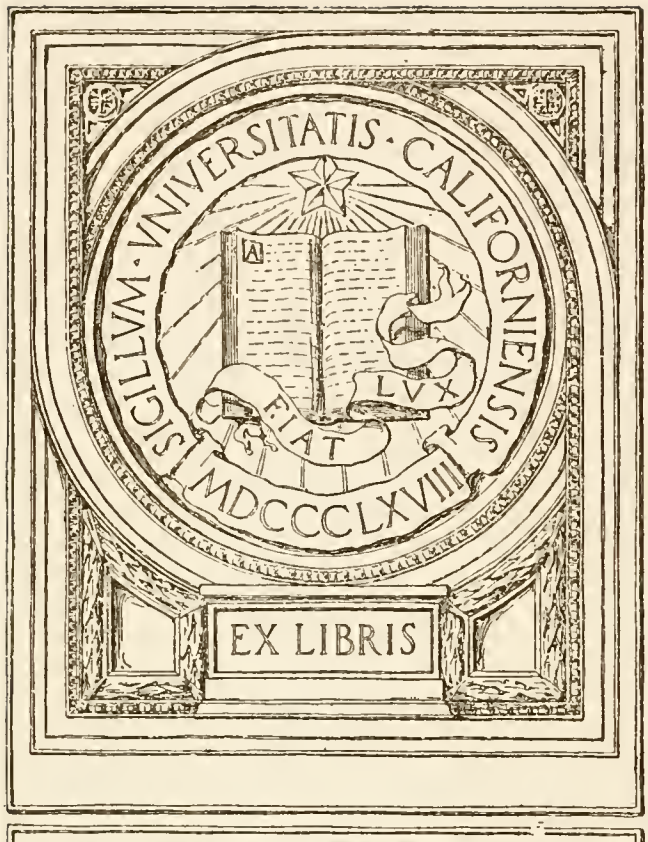

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Form 324.
January, 1921.
FACTORY DEPARTMENT,
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MEMORANDUM

ON

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INDUSTRIAL LEAD POISONING.

UNIVERSITY OF CALIFORNIA

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INDUSTRIAL LEAD POISONING.

Valuable information as to the frequency, symptoms, and etiology of lead poisoning is obtained from the statutory obligation placed on medical practitioners in Great Britain and Ireland by Section 73 of the Factory and Workshop Act, 1901, to notify to H.M. Chief Inspector of Factories cases of lead poisoning contracted in a factory or workshop, and from the subsequent reports made by the Certifying Factory Surgeons. Industrial plumbism is practically always the result of inhalation and absorption, from either the alimentary or pulmonary tracts or both, of dust and fumes. Uncleanliness and carelessness on the part of the worker are contributory causes. The susceptibility of women to the influence of lead is usually accepted as being greater than that of men. Figures in the pottery industry seem to show that women are about twice as susceptible as men, but this may be due either to the relatively greater danger in the processes in which women predominate, or to their average shorter duration of employment. The records of plumbism show that two-fifths of all reported cases occur during the first eighteen months of employment. There is, at all events, no doubt as to the baleful influence exerted by lead on the uterine functions. Disorders of menstruation are common, the tendency to miscarriage in some lead workers is so pronounced that only after giving up the work altogether can full term be reached. The Recommendation of the General Conference of the International Labour Organisation held at Washington in 1919 urged that " In view of the danger involved to the function of maternity, and to the physical development of women, and young persons under the age of 18 years, they should be excluded from employment in the following processes :—

(*a*) In furnace work in the reduction of zinc or lead ores.

(*b*) In the manipulation, treatment, or reduction of ashes containing lead, and in the desilverising of lead.

(*c*) In melting lead or old zinc on a large scale.

(*d*) In the manufacture of solder or alloys containing more than 10 per cent. of lead.

(*e*) In the manufacture of litharge, massicot, red lead, white lead, orange lead, or sulphate, chromate or silicate (frit) of lead.

(*f*) In mixing and pasting in the manufacture or repair of electric accumulators."

It was further recommended " That the employment of women and young persons under the age of 18 years in processes involving the use of lead compounds be permitted only subject to the following conditions :—

(*a*) Locally applied exhaust ventilation, so as to remove dust and fumes at the point of origin.

(*b*) Cleanliness of tools and workrooms.

(*c*) Notification to Government authorities of all cases of lead poisoning, and compensation therefor.

(*d*) Periodic medical examination of the persons employed in such processes.

(*e*) Provision of sufficient and suitable cloakroom, washing, and mess room accommodation, and of special protective clothing.

(*f*) Prohibition of bringing food or drink into workrooms."

These points have been embodied in the "Women and Young Persons (Employment in Lead Processes) Act, 1920."

For 20 years past the principal branches of manufacture which have been observed to be connected with lead poisoning have been classified under the following headings, which will serve to call attention to the sources of danger and also help to confirm diagnosis of plumbism in a person engaged in such occupation—

TABLE I.

Industry.	Average 1900–04.	Average 1905–09.	Average 1910–14.	Average 1915–19.
Smelting of Metals— ... ... (*a*) Lead smelting, *121*; (*b*) Desilverising, *11*; (*c*) Spelter, *64*; (*d*) Other, *4*.	37[2]	45[2]	40[1]	34[2]
Brass— ... ... (*a*) Polishing, *19*; (*b*) Chandelier fitters, *7*; (*c*) Casting, &c., *11*.	8	7	7	1
Sheet Lead and Lead Piping— ... Melting Pot, *16*; Elsewhere, *17*.	13	9	7	2
Plumbing and Soldering— ... ... (*a*) Red and White Lead, *70*; (*b*) Soldering and lead burning, *88*.	20[1]	23[2]	32[2]	19[1]
Printing— ... ... (*a*) Compositors, *69*; (*b*) Stereotypers, Linotypers, &c., *54*; (*c*) Others, *23*.	18[1]	22[2]	29[2]	13[2]
File Cutting— ... ... (*a*) Cutting, *53*; (*b*) Hardening, *12*.	32[3]	11	13[1]	3[1]
Tinning— ... ... (*a*) Hollow-ware, *36*; (*b*) Iron drums and kegs, *18*; (*c*) Harness furniture, *10*.	10	18	13	3
White Lead	183[4]	76[3]	31[1]	17
Red Lead	13	9	8	11
Pottery— ... ... (*a*) Dipping, *79*; (*b*) Dippers' assistants, *45*; (*c*) Warecleaning, *54*; (*d*) Glost placing, *82*; (*e*) Majolica painting, *15*; (*f*) Ground laying, *8*; (*g*) Colour and litho dusting, —; (*h*) Enamel colour and glaze blowing, *22*; (*i*) Colour makers and millers and mixers of glaze or colour, *24*; (*j*) Other persons in contact with lead, *10*.	119[5]	94[7]	67[10]	19[6]

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TABLE I.—*continued.*

Industry.	Average 1900–04.	Average 1905–09.	Average 1910–14.	Average 1915–19.
Litho Transfer-making	5	5	1	—
Glass Cutting and Polishing	6[1]	3[1]	2[1]	—
Enamelling— ... ... (*a*) Iron and glass, *10*; (*b*) Copper letters, *1*; (*c*) Opal signs, *3*; (*d*) Porcelain enamelling, *47*.	6	4	12	2
Electric Accumulators	32	25[1]	36	40[1]
Paints and Colours	46[1]	39[1]	20	12
Coach Building— ... ... (*a*) Railways and tramways, *185*; (*b*) Motor cars, *78*; (*c*) Perambulators, *21*; (*d*) Other, *102*.	64[4]	75[4]	77[5]	23[3]
Shipbuilding— ... ... Government Dockyards, *46*; Other, 107.	29[1]	24[1]	31[3]	16[2]
Paint used in other industries	46[2]	45[2]	49[2]	16[1]
Other Industries— ... ... (*a*) Tempering springs, *10*; (*b*) Other contact with molten lead, *91*; (*c*) Metal sorting, *7*; (*d*) Handling lead, *12*; (*e*) Shot, *2*; (*f*) Other contact with metallic lead, *27*; (*g*) Indiarubber, *26*; (*h*) Glass making, *3*; (*i*) Yarn dyed with yellow chromate of lead, *32*; (*j*) Other lead compounds, *116*; (*k*) Other tinning, *7*; (*l*) Coopering, *4*; (*m*) Other, *30*.	66[2]	65[2]	73[3]	48[2]
Total	753[27]	599[28]	548[34]	279[21]

The principal figures relate to cases, the small figures to deaths. Fatal cases not reported in previous years are included as both cases and deaths.

The figures in italics after the processes relate to the actual number of cases included in Returns during the 5 years, 1910-14.

The diminution in the number of cases in the period 1915-19 is an effect of the war which adversely affected several lead industries.

Close analysis of the reports by the Certifying Factory Surgeons, following on the medical practitioner's notification, has brought out certain essential facts about lead poisoning. Thus, comparison can be made of the cases reported in three five-yearly periods from 1900 to 1914; in respect of (1) increase or decrease in the number recorded; (2) severity of attack; (3) number of attack—that is, whether first, second, third or chronic; (4) main symptoms, and shows the progress made in prevention. Taking the figures as a whole, the most noticeable feature is reduction in severity and in the number of chronic cases.

TABLE II.

	Severity of Attack.									
	Severe.		Moderate.		Slight.		Not stated.		Total.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1900–1904 Cases ...	1,020	137	640	128	1,324	273	88	26	3,072	564
1900–1904 Per cent. ...	33·2	24·3	20·8	22·7	43·1	48·4	2·8	4·6	100	100
1905–1909 Cases ...	568	67	749	141	1,198	223	50	6	2,565	437
1905–1909 Per cent. ...	22·1	15·3	29·2	32·3	46·7	51·0	1·9	1.4	100	100
1910–1914 Cases ...	450	27	790	117	1,184	141	27	6	2,451	291
1910–1914 Per cent. ...	18·4	9·3	32·2	40·2	48·2	48·5	1·1	2·1	100	100

	Number of Attack.									
	1st.		2nd.		3rd or chronic.		Not stated.		Total.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1900–1904 Cases ...	2,019	419	462	87	460	26	131	32	3,072	564
1900–1904 Per cent. ...	65·7	74·3	15·0	15·4	15·0	4·6	4·3	5·7	100	100
1905–1909 Cases ...	1,781	380	409	32	298	20	77	5	2,565	437
1905–1909 Per cent. ...	69·4	86·9	15·9	7·3	11·6	4·6	3·0	1·1	100	100
1910–1914 Cases ...	1,863	260	305	17	251	8	32	6	2,451	291
1910–1914 Per cent. ...	76·0	89·4	12·5	5·8	10·2	2·7	1 3	2·1	100	100

In seeking to ascertain the cause for this reduction in severity, the next table must be consulted, which gives the symptoms recorded. Usually a combination of symptoms is stated, and each one has been entered under the appropriate heading.

TABLE III.—TABLE SHOWING TOTAL OF SYMPTOMS.

	Main Symptoms.													
	Gastric.		Anæmia.		Head-ache.		Paretic.		Encepha-lopathy.		Rheu-matic.		Other.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1900–04 Cases ...	2,521	431	619	132	278	120	577	68	113	45	289	64	47	5
1900–04 Per cent.	82·1	76·4	20·2	23·4	9·0	21·3	18·8	12·0	3·7	8.0	9·4	11·3	1·5	0·9
1905–09 Cases ...	1,991	348	854	193	261	135	613	85	87	17	279	43	129	11
1905–09 Per cent.	77·6	79·6	33·3	44.2	10·2	30·9	23·9	19·5	3·4	3·9	10·9	9·8	5·0	2·5
1910–14 Cases ...	1,853	225	825	112	303	81	333	15	53	10	293	28	186	12
1910–14 Per cent.	75·7	77·3	33·7	38·5	12·4	27·8	13·6	5·2	2·6	3·4	12·0	9·6	7·6	4·1

The total number of symptoms, therefore, greatly exceeds the number of cases, but this does not affect the correctness of the estimate of each one on the total number of cases reported. The symptoms which generally lead to the report of cases as "severe"

are paralysis and encephalopathy, and these are shown to have been reduced in the third period. Tabulation of these figures over a number of years has consistently shown that paralysis is more frequently met with in men than in women, while the reverse is the case with encephalopathy. The forms of paralysis and, separately, the cases in which weakness or loss of power in the particular muscles was stated, are given in the following Table :—

TABLE IV.

Forms of Paralysis, 1910-1914.

Part affected.		Total 1910—1914.		
		Paralysis.	Weakness of or loss of power of muscles.	Total
Arms and leg	Complete ...	6	—	6
	Partial ...	14	30	44
Legs	Complete ...	3	—	3
	Partial ...	6	20	26
Both forearms	Complete ...	102	—	102
	Partial ...	100	161	261
Right forearm	Complete ...	30	—	30
	Partial ...	22	20	42
Left forearm ...	Complete ...	9	—	9
	Partial ...	10	16	26
Fingers		19	4	23
Neuritis (including numbness of hands and arms)		18	—	18
Other (including paralysis of deltoid, muscles of speech, locomotor ataxy, and general paralysis)		14	2	16
Total		353	253	606

Reduction in the severe cerebral symptoms is very important, as their occurrence must be regarded as due to inhalation of lead dust or fume in excessive amount, and indicates failure, therefore, at some point or other in precautionary measures.

TABLE V.

Encephalopathy, 1905-1919.

Symptom.	Total 1905–1909.	Total 1910–1914.	Total 1915–1919.
Epilepsy and Epileptiform attacks.	64	39	8
Mental Defect...	13	16	3
Optic neuritis...	20	5	6
Total	97	60	17

Analysis of 247 death certificates (including those of 132 house painters) in which lead poisoning was entered as directly or indirectly the cause showed that Bright's disease, cerebral hæmorrhage, paralysis, or chronic lead poisoning, either alone or as a combination of symptoms, accounted for at least 195 (78·9 per cent.), and encephalopathic symptoms for 8 (3·2 per cent.).

Reference to Table I. shows that the continued diminution in cases is not accompanied relatively by a corresponding fall in the number of deaths of which information is received. This seeming anomaly is the result of more frequent association now than formerly, following on the operation of the Workmen's Compensation Act, 1906, of lead poisoning on death certificates of lead workers suffering from chronic nephritis and its sequelæ.

The attack rate per thousand among those exposed to lead poisoning in some lead industries can be shown approximately as in the following table.

The fact should not be forgotten, however, that reported cases of lead poisoning in common with other forms of industrial disease do not represent quite all the incidence : latent, unrecognised and neglected cases undoubtedly exist as with other notifiable diseases.

TABLE VI.

Industry.	Approximate Number of Persons Employed in Lead Processes.		Number of Reported Cases.				Attack-rate per Thousand.			
	1913.	1914.	1911.	1912.	1913	1914.	1911.	1912.	1913.	1914.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
White lead	1,201	1,119	41	23	29	29	29	17	24	26
Vitreous enamelling ...	933	768	19	5	9	11	22	5	10	14
Tinning of metals	878	492	13	15	9	10	21	17	10	20
Electric accumulators ...	1,475	1,543	24	38	44	41	21	30	30	27
Paints and colours... ...	1,100	1,287	21	19	22	21	14	13	16	16
Pottery	7,085	4,661	92	80	62	28	15	13	9	6
Smelting of metals... ...	2,878	2,827	48	56	26	36	17	23	9	13
Coach painting	29,308	29,308	104	84	71	57	1	3	2	2
File cutting...	5,556	5,556	18	13	14	11	3	2	3	2
Printing	58,777	58,777	32	37	21	23	0·5	0·6	0·4	0·4

Briefly, the precise cause of the incidence in the 18 industries mentioned in Table I. is—

In *smelting of metals* from the fume and dust inhaled at the blast and refining furnaces, in *desilverising* from the fume given off at the cupola, and from the dust and fume in preparation of litharge ; in *spelter* (zinc manufacture) from the fumes given off from the small amount of lead (2—3 per cent.) which comes off as fume in the distillation of the charge ; in *brass*, a rather indefinite group having the one point in common of work in connection with brass, the cause in *casting* would be from the

small quantity of lead (1·5 per cent.) added to soften the metal, in *polishing* from the small amount of lead in the abraded dust, and in *chandelier fitting* from testing by the mouth (now much less common than formerly) the efficiency of the joint when made with a paste of white lead; in *sheet lead and lead piping* from the dust in skimming off the dross from the molten metal and handling the old and dusty oxidised lead piping, etc., in *plumbing* and *soldering*, from handling red and white lead for jointing, from soldering with a bit and, more certainly, from lead burning with oxy-hydrogen or oxy-acetylene blow pipe flame; in *printing* from the dust in the type cases and drossing molten metal; in *file making* from the use of lead beds, and in *file hardening*, *i.e.*, tempering, from the fume in the bath of molten lead into which the file is plunged; in *tinning* from the chemical interaction between hydrochloric acid used in cleaning and the molten mixture (usually half tin and half lead) evolving soluble lead chloride vapour. In *white lead works* the remarkable diminution in reported plumbism is due to (1) improved structural conditions; (2) adoption of mechanical means (cranes, rails, hoists, etc.) for conveyance of material in substitution for hand carrying; (3) exhaust ventilation where dust arises as in packing and paint mixing; (4) periodic medical examination; (5) diminution in height of the stoves or adoption of mechanical drying stoves and (6) conversion of white lead into paint by means of direct mixture with oil while in the pulp stage. The reduction in the case of *red lead* is due to the adoption of automatic mechanical methods—the mechanics engaged in repairs are now the persons to suffer. The cause of lead poisoning in *pottery* manufacture is from dust and splashing in the processes of dipping, ware cleaning, aerographing, etc. Diminution in this large industry is due mainly to the improved conditions, notably in exhaust ventilation locally applied to remove dust and fumes at the point of origin, and increase of the use of low solubility and leadless glazes. Poisoning in *glass cutting* arises from the spray of putty powder (lead oxide); in *enamelling* from the powdered glaze (in this industry leadless have largely replaced lead glazes).

The *electric accumulator* industry is that now exposing workers to the greatest risk of plumbism. Analysis of 200 cases shows incidence to be proportionately as follows :—

> *Casting*, 9·5; *pasting* (*including mixing and drossing*), 31·0; *lead burning*, 15·5; *trimming*, *filing*, *sawing*, *wire brushing*, *and cleaning*, 19·0; *trucking and handling plates*, 9·5; *smelting and handling old accumulator plates*, 5·5; *other* (*including formation*, *sweeping*, *erecting outside*, *etc.*), 10·0.

Use of machines for pasting and attention to detail in the application of exhaust in mixing and weighing lead compounds, in trimming, wire brushing, filing of lugs and lead burning alone will reduce it. The cause of poisoning in *paints and colours*, where the object is necessarily to reduce lead colours to the finest state of division, is obvious; in *coach building* and in *paints used in other industries*, to sand papering painted surfaces and,

to some extent also, to lack of facilities for washing; in *shipbuilding*, to chipping and scraping off old lead paint (often in confined spaces such as double bottoms, tanks, and bilges), and occasionally from fumes given off in inserting red-hot rivets into holes containing yarn soaked in red lead and oil. The importance of distributing cases under the vague heading *other industries* has led to tabulation of them in the five-year period 1910-14 in the following way, which gives an easy key to the source of poisoning :—

> (*a*) *Tempering springs*, 10; (*b*) *other contact with molten lead*, 91; (*c*) *metal sorting*, 7; (*d*) *handling lead*, 12; (*e*) *shot making*, 2; (*f*) *other contact with metallic lead*, 27; (*g*) *indiarubber*, 26; (*h*) *glass making*, 3; (*i*) *yarn dyed in yellow chromate of lead*, 32; (*j*) *other lead compounds*, 116; (*k*) *other tinning*, 7; (*l*) *coopering*, 4: (*m*) *other*, 30; *total*, 367.

In *tempering springs* and *other contact with molten lead* the cause is from dust in drossing; in *metal sorting* and *other contact with metallic lead*, from dust; in *shot making*, from friction in the grading and sifting operations; and in *indiarubber*, *glass making* and *other lead compounds* and *coopering* from dust.

In the whole of these cases, therefore, not a single one can be said to be unassociated with dust or fume.

Means for prevention, apart from substitution of innocuous materials for those containing lead (as, for example, leadless or low solubility fritted glazes for carbonate of lead in pottery, or zinc oxide paint for white lead), are sufficiently indicated in the Recommendations of the International Labour Organisation already quoted. Meticulous attention to detail is needed in securing as perfect a locally applied system of exhaust vetilation as possible for the removal of fumes or dust.

Symptoms and Diagnosis.

A *blue line* on the gums by itself indicates rather the presence of lead than lead poisoning, but as a danger signal and as affording confirmation of the exact etiology and other symptoms it is a valuable sign. Presence of a marked blue line in a workman will at once show that not only he himself, but all his fellow workers in the particular process, must be running grave risk from fumes or dust containing compounds of lead, that poisoning must have occurred in the past and will certainly occur in the future, and that if work has been continued for years under these conditions constitutional effects on the circulatory and excretory system must have gone far. In many instances such a line would be lessened or removed by cleanliness of the teeth, without changing conditions of exposure to the lead.

Anæmia.—The first action of lead when absorbed into the system is on the blood and circulatory system, diminishing the

number of red cells and the amount of hæmoglobin, and impairing the organs from which fresh blood-cells are produced. Facial pallor due to interference with the nerve supply of the blood vessels is frequently noted. Among males anæmia is comparatively rare, and its significance when associated with loss of subcutaneous fat particularly noticeable in the orbit and buccinator region in the face of a lead worker is consequently greater. In lead workers, more particularly in men, there is sometimes developed a special type of anæmia, with glistening cornea and sclerotic, suggesting organic disease of the heart which, however, does not necessarily co-exist.

Changes in the blood are often found in cases of incipient and acute lead poisoning characterised by alteration in shape and basophile staining of some of the red cells. Some authorities regard the finding of 100 basophile red cells per million as evidence that lead absorption has passed into the stage of lead poisoning after other causes normally giving rise to basophilia have been excluded.

Colic.—The digestive symptoms often associated with plumbism include habitual constipation and attacks of colic. Cases are reported, however, not infrequently where the colic is accompanied by diarrhœa or by constipation alternating with diarrhœa. The chief points associated with lead colic are (1) the intermittent character; (2) the relation of the colic mainly to the lower part of the abdomen; (3) slowing of the pulse; and (4) the relief afforded by firm pressure of the abdomen. Colic accounts for fully 75 per cent. of the notifications.

Arthralgia.—The pain which may accompany any of the forms of lead poisoning does not usually follow the course of the nerve trunks, but is localised near the large joints (lead arthralgia) generally the knee, elbow, or shoulder. The condition is probably myalgic in character.

Nervous System.—Attacks of vertigo or persistent headache are significant in persons exposed to lead poisoning, and so too are tremor and numbness or impairment of muscular action.

The most serious menace to life in acute lead poisoning arises from cerebral manifestations known generally as encephalopathy, a term which includes convulsions, delirium, coma, amaurosis, insanity, etc. Epileptiform seizures are most commonly met with in young women, and may appear in them after a short term of work in lead. Occurrence of this severe form of lead poisoning —now rare—calls for the fullest inquiry, with a view to remedying defects in the processes of manufacture. Post-mortem minute hæmorrhages in the substance of the brain have been found. The existence of hysterical symptoms previous to the onset of the seizures has been noticed, and as a prodromal symptom it should, therefore, arouse grave suspicion. The difficulty of distinguishing ordinary epileptic seizures from attacks of true lead encephalopathy raises the question whether persons who are the subjects

of idiopathic epilepsy can be suitably employed in lead processes. Associated sometimes with epileptiform seizures is neuro-retinitis, which may pass on to optic atrophy.

Persistent headache is a late and grave symptom, not to be confused with the transient headache associated with colic.

Mental symptoms may be grouped as (1) toxæmic, with sensory disturbance which tend rapidly to improve on removal from exposure; (2) hallucinations of sight and hearing, more chronic in nature, which may be permanent; (3) those resembling general paralysis with tremors, increased knee jerks, inco-ordination, accompanied by listlessness amounting to dementia, but which tend to get well.

Paralysis.—The most frequent pronounced nervous symptom of lead poisoning is the well-known "dropped wrist," due to paralysis of the extensors of the fingers and wrist; that is, the muscles supplied by the musculo-spiral nerve (except the supinator longus, which has an additional nerve supply and is, moreover, more a flexor than an extensor muscle).

Although paralysis affects chiefly the extensor muscles of the wrist and fingers other groups of muscles become involved, more especially the deltoid and biceps, those of the thenar and hypothenar eminences as in file cutters as a result of overstrain. The degree of strain to which particular muscles are put seems to influence the direction and extent of the paralysis.

Interstitial Nephritis.—Direct inflammation of the vessel walls, resulting in obliterative arteritis, arterio-sclerosis and degeneration and exudation in the kidney, lung and liver, are due to degenerative changes either in the intima or the middle coats of the finer vessels. In the kidney such vessel changes are the precursors of disease, and albumen is found in the urine, but the quantity is rarely very large. Only incidental allusion need be made to the later stages of chronic plumbism where sclerotic changes have taken place in the kidneys and blood vessels, so that the symptoms and dangers always associated with chronic interstitial nephritis are present. Cerebral hæmorrhage at a comparatively early age is a frequent cause of death in lead workers.

Gout.—Investigation by Goadby* suggests that the condition of gout in painters is to a great extent attributable to turpentine.

Periodic Medical Examination.

In the periodic medical examination of lead workers, the surgeon should remember his objects are (1) to prevent lead poisoning and minimise lead absorption, and (2) to obtain information for the occupier of the relative danger of one process and another with a

* Lead Poisoning and Lead Absorption, by Legge and Goadby (Edward Arnold, London), 1912.

view to adoption of remedial measures. That examination is useless which merely records entries in a book without following them up. Special attention should be paid to new workers because development of signs in them constitutes the surest guide to defects in the processes of manufacture. The surgeon can examine the outstretched hands by placing the tip of the forefinger of his own in the outstretched hand of the worker and the ball of the thumb on the extreme tip of each finger gently pulling it down, noting the spring present in the muscles. This test is probably the most delicate there is for detection of early extensor paralysis. Sometimes the strength of the wrists and fingers of all the workers is rapidly estimated by the surgeon placing his palms on the dorsum of the patient's outstretched hands, and seeing whether the patient can be prevented from lifting them without flexing the wrists or finger joints. The test detects (1) paralysis which has been recovered from; (2) commencing partial paralysis; and (3) weakness of muscular power, especially in those who have worked in lead for a number of years. This weakness appears to be an effect of lead upon the muscular tissue or dependent on debility the result of lead absorption, and independent of nerve implication. The condition often remains unaltered for years, or undergoes alteration, being at times absent for months together.

Somewhere about 2 milligrammes (or 0·002 gramme of lead) is the lowest daily dose which, inhaled as fume or dust, may, in the course of years set up chronic plumbism. Probably if the air breathed contains less than 5 milligrammes per 10 cubic metres of air, cases of encephalopathy would never, and cases of colic very rarely, occur. And this is a quite practical figure to keep the dust down to in any process amenable to exhaust ventilation.

Notification, Suspension, Warning.

If in the course of the examination the Surgeon meets with a notifiable case of lead poisoning, he should notify it on Form 303. If, however, the Surgeon is the Certifying Surgeon for the District, the notification is not required: he should proceed at once with investigation and report on Form 190).

The necessity for notification does not arise until lead poisoning is diagnosed, and, in general, not unless the symptoms are of such a nature as to require abstention from work, but in deciding the question of suspension or fitness for work in lead, other considerations come in. Liability to injurious effects may be indicated by present or past attacks of lead poisoning, by tendency to hysteria and epilepsy, by marked anæmia (not necessarily due to lead), by existence of extensive oral sepsis, by mental weakness, by careless personal habits, such as want of attention to cleanliness of hands and teeth or of clothing, or biting of nails, or taking food in prohibited places (or with unwashed hands, after working in lead), or neglect of other precautions prescribed

by Regulations. Unsuitable subjects for processes in which there is risk of exposure to dust and fumes of lead compounds are those who have suffered from malaria or any condition which has brought about blood destruction and ex-soldiers who have been gassed. Indirectly, shortsightedness predisposes to danger, by causing undue proximity to the work. In women the question of pregnancy has to be borne in mind. It is illegal for a woman to be employed in any factory or workshop within four weeks after confinement, and where the work is such as to involve the grave additional risk of plumbism a longer interval becomes necessary.

Some degree of immunity may be inferred from protracted employment in lead without recent manifestations of the more serious forms of plumbism, especially in processes amenable to exhaust ventilation locally applied for the removal of dust. Each case, therefore, requires to be considered on its merits.

Where the diagnosis of acute plumbism is clearly established there should be no hesitation in ordering suspension from ordinary employment, and advising transference on recovery, if possible, to other processes not exposing to risk. Whether the predisposing cause in such instances be natural susceptibility or merely careless habits, the unfitness for work in lead is equally obvious.

The duration of suspension from work rests with the discretion of the Surgeon. In general, it may be said that a temporary suspension should suffice in cases of slight and transient attack, but repeated or grave attacks call for prolonged exclusion from work in lead, and usually for discontinuing it altogether.

In every case before work is resumed a certificate permitting this should be entered in the Health Register.

Short of suspension, conditions are met with which call for a caution to the workers, and careful observation on the part of the Surgeon. Special attention should be directed at each examination to those who have been allowed to resume work in lead processes after an attack of plumbism; to those who present equivocal symptoms in any way suggesting plumbism; to those who have even a trace of a blue line; and to women workers who are pregnant. In such cases the question of transfer to non-lead processes should be considered.

The value of the periodic examination in impressing upon the workpeople the importance of habits of cleanliness, and of attention to the prescribed Regulations, cannot be too strongly insisted upon. A cautionary leaflet (Form 406) is supplied on application, for distribution among persons commencing employment in lead processes.

If any difficulty, or apparent breach of Regulations is met with, the District Inspector should be informed.

Regulations.

The following codes of Regulations, applying to lead industries, require examination of certain employees, either by the Certifying Surgeon or by a specially appointed practitioner who may be the

Certifying Surgeon. Sometimes the occupier may wish the Surgeon to extend his examination to employees in other processes than those which the Regulations specifically mention. Copies of the Regulations are supplied to Surgeons concerned.

Codes.	Medical Examinations.		Health Register.
	Periodical.	On first employment, within	
REGULATIONS—			
Heading of yarn (dyed with lead)	Quarterly.*	—	Form 605.
Vitreous enamelling of metal and glass			
Tinning of metal hollow-ware, &c.			
Electric accumulators: manufacture	Monthly.	—	Form 605.
Paints and colours: manufacture			
Lead smelting and manufacture of red lead, orange lead, flaked litharge ...			
Pottery: manufacture and decoration	Monthly.†	One week.‡	Form 655.
Compounds of lead: manufacture	Weekly.*	—	Form 605.

* Or such other intervals as may be prescribed by the Chief Inspector of Factories.

† For certain kinds of employment (not entailing exposure to lead) *yearly*, and for others *half-yearly*, examinations are required.

‡ For "permission to work" in certain non-lead processes.

The precise duties devolving on the Surgeon are set out in each code, and may include—

(*a*) Attendance at the works at appointed times to be arranged with the occupier and made known to the employees concerned. Alteration by the Surgeon of the appointed time should, whenever possible, be made known beforehand.

(*b*) Examination at those times of all employees presented for the purpose. (The arrangements for examination should be such as to secure adequate privacy, *e.g.*, the exclusive use of a room. If this be wanting, the attention of the occupier should be directed to the matter, and, failing compliance, the District Inspector should be informed.)

(*c*) Entry of the results of each examination in the prescribed Health Register provided by the occupier and kept at the works; showing the fitness or unfitness of each employee for employment in the dangerous processes, and formally suspending where necessary any employee from such employment.

(*d*) Special examination of individual employees, on their application, with entries as above. Any certificate (of suspension, or allowing resumption of work after suspension) granted upon such an examination should be notified at once to the occupier and entered in the Health Register on the Surgeon's next visit to the works.

Health Register.

The object of the Health Register is to keep a record intelligible, not only to the occupier and Inspector, but also to the workers. Entries on a uniform system are desirable, and Surgeons, therefore, are asked to make them as below. They should indicate degrees of deviation from normal health, and distinguish (by use of *numerals*) those attributable (or possibly attributable, in whole or part) to work in lead, from those not so attributable, for which latter *letters* should be used. The conclusion is perhaps best expressed as $\frac{1}{A}$, $\frac{2}{C}$, and so on.

The numerals should be taken to mean :—

1. Passed without comment (no observed effect of lead)
2. Blue line (or indication thereof).
3. Lead anæmia or other impairment of health.
4. Suspension or transfer, by reason of impairment of health from effects of work in lead.

Except in the case of a worker whose exposure to lead is only recent, renal disease should always be indicated by a numeral.

Letters should bear the following meaning :—

A. No comment (*i.e.*, fair general health).

B., C. Increasing degrees of impairment of general health. (Pregnancy, if without suspension, should be entered as C.)

D. Suspension or transfer, for reasons other than impairment of health from effects of work in lead.

X. Carelessness, or neglect of precautions, or unsuitability for work in lead. (Suspensions for such reasons should be marked DX.)

Occasionally use of a Health Register on the card system is preferred and no objection can be raised to this provided the entries to be made are a facsimile of those in Forms 605 and 655.

The importance of the conclusions to be drawn from the notifications and reports upon them received from year to year, calls for careful examination and tabulation of these cases, for which purpose it is necessary that precise information as to occupation (including of course not merely the manufacture carried on, but the particular work done by the patient), probable causation of plumbism, and symptoms and degree of severity of the attack, should be given by the Certifying Surgeon in his report.

Every effort is being made by the Home Office, by the exercise of powers under the Factory Acts and Regulations, and by investigation of the conditions of manufacture, to reduce as far as possible the danger of lead poisoning in those industries in which it occurs. For this purpose it is necessary that all cases of plumbism in factories and workshops should be reported, and that full and prompt enquiry should be made into the circumstances of each case.

The duties under section 8 of the Workmen's Compensation Act, 1906, devolving on Certifying and Appointed Surgeons in connection with lead poisoning, are outside the province of the Factory Department.

Factory Department,
Home Office.

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